HYDROLOGY

Precipitation

The Jacks Fork Watershed is situated in one of the wetter parts of the state. Data available from the National Climatic Data Center (NCDC 1999) for 9 National Weather Service and cooperative stations located around the watershed, indicate an average annual precipitation of 43.21 inches for the period of 1936-1995. (Figure Hy01 and Hy02). The maximum recorded annual precipitation amount at an individual station during this period was 64.53 inches, while the minimum recorded annual precipitation during this period was 20.04 inches. Average annual precipitation in the watershed has increased over time. A comparison of average annual precipitation for two time periods 1936-1965 and 1966-1995, indicates an increase of 3.27 inches (8%) within the watershed. Figure Hy02 shows annual precipitation amounts as well as average annual amounts for the previously discussed time periods. Average monthly precipitation data for the period 1936-1995 indicates that the combined months of April, May, and June receive the most precipitation at 13.35 inches. The combined months of December, January, February receive the least amount of precipitation at 8.81 inches. Average monthly precipitation data for the period 1936-1995 indicates that May receives the most precipitation (5.01 inches) while January receives the least (2.61 inches) (Figure Hy03). Distribution of monthly precipitation amounts has shifted over time. Average monthly precipitation comparisons between the periods 1936-1965 and 1966-1995 indicate an increase in precipitation in 9 of the months, while the remaining 3 months have experienced a decrease in precipitation. The most notable change has been an increase in the amount of average monthly precipitation occurring in the months of August, September, October, November, and December (Figure Hy04).

United States Geological Survey Gaging Stations

The United States Geological Survey (USGS) currently (1999) has three active stream discharge gaging stations within the Jacks Fork River Watershed (Table Hy01 and Figure Hy01) (USGS 2000a and USGS 2000b). Station #07066000 http://waterdata.usgs.gov/nwis-w/MO/?statnum=07066000 is located on the Jacks Fork River 1.5 miles downstream from Mahans Creek (USGS 1999a). The datum of the gage is 615.87 ft above sea level. Station #07066000 has been recording discharge data from October 1921 to the present. Station #07065495 http://waterdata.usgs.gov/nwis-w/MO/?statnum=07065495 is located on the Jacks Fork River 0.5 miles upstream from Alley Spring Branch. The datum of the gage is 652.74 ft above sea level. Station #07065495 has been recording discharge data from 1993 to the present. Station #07065200 http://rt02dmorll.er.usgs.gov/rt-cgi/gen_stn_pg?station=07065200 is located on the Jacks Fork River at Highway 17. The datum of the gage is 832.92 ft above sea level. Station #07065495 is a stage only station which has been recording data from 2000 to the present (Waite 2001).

In addition to the previously mentioned stations, historical discharge records exist from Station 07065500 (Alley Spring at Alley) for the periods of 1928-1939 and 1965-1979.

Daily Mean Discharge Statistics

Daily mean discharge statistics as well other long term hydrologic trends have been analyzed using data from gage station 07066000 (Jacks Fork at Eminence). This is because this station has the most complete data set and longest period of record of any station within the watershed. It is also the most downstream station within the watershed.

The daily mean (average) discharge of the Jacks Fork at Eminence is 466 cubic feet per second (cfs) (2000a). The highest daily mean discharge at this station is 31,800 cfs which occurred on November 15, 1993 while the lowest daily mean discharge is 67 cfs which occurred on September 16, 1956. Analysis of historical discharge data available through the USGS National Water Information System (NWIS) (2000b) reveals that daily mean discharge has been lowest during the months of August, September, and October and highest during March, April and May (Figure Hy05). Comparison of two time periods, 1936-1965 and 1966-1995, indicates a significant increase in daily mean discharge between the two time periods. Station 07066000 has experienced an increase in daily mean discharge of 85 cfs (20%). Comparison of percent change in precipitation (+8%) and daily mean discharge (+20%) would indicate that the increase of discharge in the latter time period is not entirely attributable to an increase in precipitation. Analysis of percent change in daily mean discharge by month between 1936-1965 and 1966-1995 indicate a substantial increase in all months except May, June, and July (Figure Hy04). The months of January and February show an increase in discharge and a decrease in precipitation. Possible explanations for contrasting changes between precipitation and discharge include a change in precipitation intensity, watershed land cover/land use, seasonal timing, duration and type (snow, rain, freezing rain) of precipitation, as well as the inherent inaccuracy associated with assigning point based precipitation measurements of varying spatial and temporal distribution to a relatively large surface area such as the Jacks Fork Watershed. The possible effects of land cover/land use change on runoff within the watershed is discussed in the Land Use/Land Cover Section of this document. However, due to a lack of quantitatively comparable (to current data) historic land cover/land use data, as well as the previously mentioned other factors, it is difficult to determine with reasonable certainty what role changing land cover has played in the shift to higher discharges. It is beyond the scope of this document to provide the necessary analysis of all factors which affect the hydrologic cycle. However, further research and analysis of these additional factors could prove useful in further determining long term hydrologic trends within the watershed in the future.

Flow Duration

Daily flow duration data for two time periods, available from the United States Geological Survey (USGS) Daily Values Statistical Program (DVSTAT) (2000c), was compared in order to determine flooding and/or drying trends of the Jacks Fork River. Figure Hy06 shows the duration of flows from 1936-1965 and 1966-1995 on the Jacks Fork River at Eminence. The flow duration curve from the latter time period shows an upward shift to higher discharges (Figure Hy06). The upward shift of the flow duration curve reflects an overall increase in discharge in the latter time period. The changes in the flow duration curve and discharge rates are an indication of possible changes in precipitation intensity, watershed land cover/land use, seasonal timing of precipitation, and duration and type (snow, rain, freezing rain, etc.) of precipitation . As stated previously, the area of the watershed has experienced an overall increase in average annual precipitation between the two time periods. In addition seasonal timing of this precipitation has shifted, if slightly, between the two time periods (Figure Hy04). Land cover/land use changes within the watershed have also possibly had an effect on flow duration. However, the variability of land use/land cover data collection methodology and analysis, as well as the spatial and temporal variability of land cover changes make it difficult to reliably determine actual quantitative land use/land cover changes which have occurred within the watershed for the previously discussed time periods. In addition, a lack of hydrologic data for the late 1800s and early 1900s leaves to speculation hydrologic trends prior to and through the "timber boom" period. As stated previously many factors exert influences on the hydrologic cycle. Analysis of all factors is beyond the scope of this document.

However, further data collection and analysis of hydrologic data will be important for determining long term trends within the watershed.

10:90 Ratio

The 10:90 ratio is used as an indicator of discharge variability. It is the ratio of the discharge which is equaled or exceeded 10% of the time to the discharge which is equaled or exceeded 90% of the time. It is useful for determining summer carrying capacity in streams as well as interbasin comparisons. The lower the 10:90 ratio the lower the variability of flow. The 10:90 ratio for the Jacks Fork at Eminence is 7:1. This is a low value relative to 10:90 values of drainages of similar size within the state (Skelton 1976). This value is similar to 10:90 values from surrounding watersheds. Table Hy02 provides comparisons of 10:90 ratios from watersheds surrounding the Jacks Fork. The relatively low 10:90 ratios of the Jacks Fork and surrounding watersheds are due in large part to the water storage and release characteristics of the karst geology. It is, however, important to note that many streams within the area (most of which do not have discharge records) are "losing" in nature and thus will typically exhibit higher 10:90 ratios. An example of this is station 07070500 (Eleven Point River near Thomasville) which has a drainage area similar in size to the that of the Jacks Fork, but which has a high concentration of losing streams and a 10:90 ratio which is three times as great.

Instantaneous Discharge

Table Hy03 lists the highest and lowest instantaneous discharge rates that have occurred at Station 07066000 (Jacks Fork at Eminence, MO), Station 07055000 (Alley Spring at Alley, MO), and Station 07065495 (Jacks Fork at Alley Spring, MO).

7-day Q2, Q10, Q20 Low Flow and Slope Index

Q2, Q10, and Q20 seven day low flows refer to the lowest 7 day discharges that have a recurrence interval, on average, of 2, 10, and 20 years respectively. Some of the issues which low flow statistics help answer include the relative permanency of a stream and thus the streams ability to support aquatic life, the influence of groundwater in a particular watershed, as well as addressing issues related to effluent discharge. Seven day low flow statistics have been calculated for the The Jacks Fork River at Eminence. The Jacks Fork River at Eminence has seven day Q2, Q10, and Q20 low flow values of approximately 122, 86, and 76 cfs, respectively. When analyzed relative to drainage area, these values are relatively similar to those of surrounding watersheds which, as a basic rule, tend to have the highest sustained low flows in Missouri (Skelton 1976).

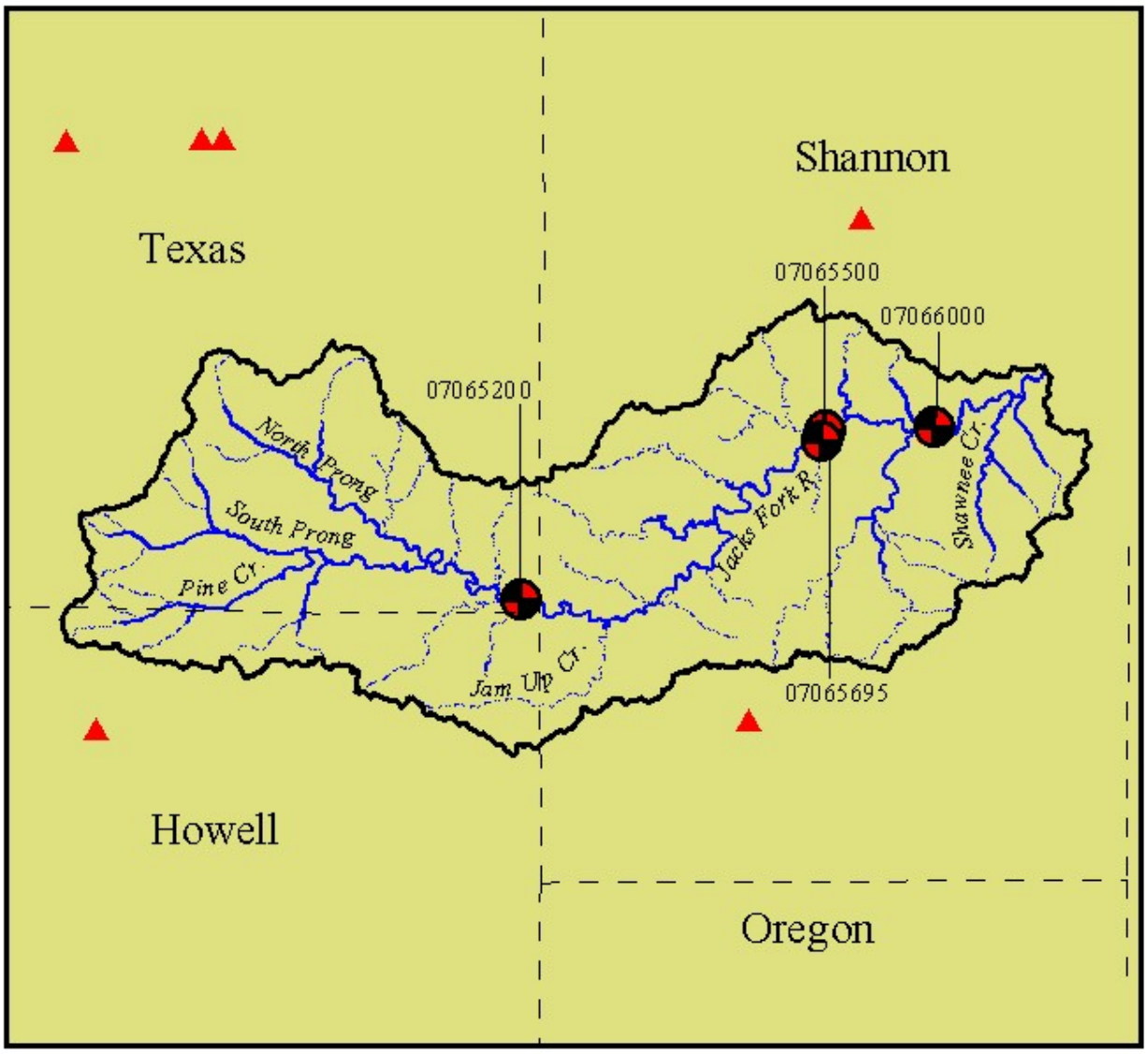
The slope index (SI, ratio of the seven day Q2 to Q20) was calculated for the Jacks Fork River at Eminence for discharge data between 1936 and 1995. The SI was 1.6. This is a low slope index, an indication of low variability in annual low flows.

Flood Frequency

Table Hy04 indicates the frequency and magnitude of flooding on the Jacks Fork River at Eminence, Missouri (Station 07066000). Flood frequencies and magnitudes range from 11,900 cubic feet per second (cfs) with a frequency of two years to 102,000 cfs for a 500 year frequency (Alexander and Wilson 1995).

Figure Hy01.

Jacks Fork Watershed
Hydrologic Stations



4 0 4 8 Miles

Legend

- Watershed Boundary
- Precipitation Station

USGS Surface Discharge Gage Station

- Active (1999)
- Inactive (1999)

N

Figure Hy02. Mean annual precipitation amounts from National Weather Service and cooperative stations in the Jacks Fork Watershed area for years 1936-1995 (NCDC 1999). n=number of annual measurments available for period of record.

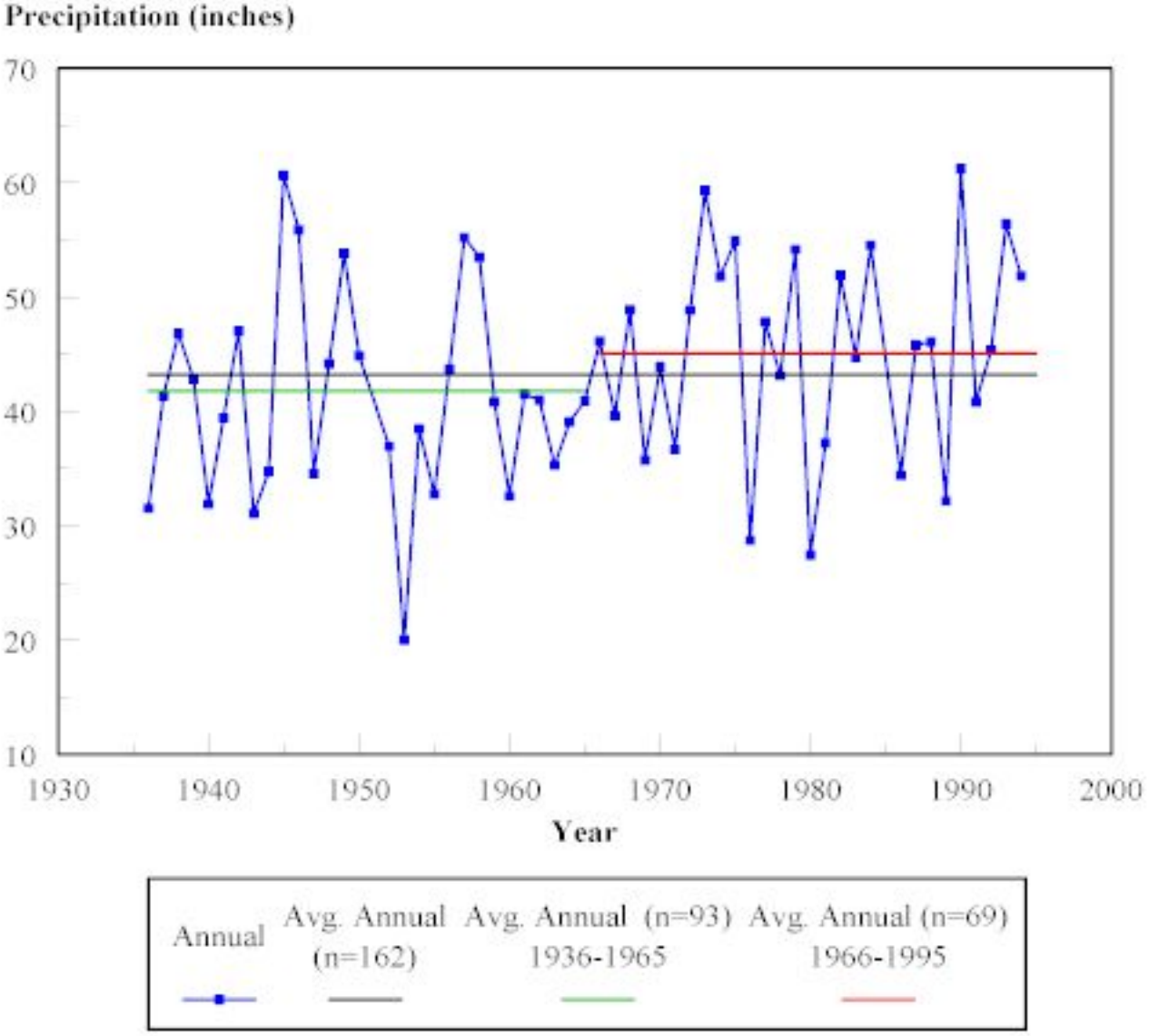


Figure Hy03. Mean monthly precipitation amounts from National Weather Service and cooperative stations in the Jacks Fork Watershed area (NCDC 1999).

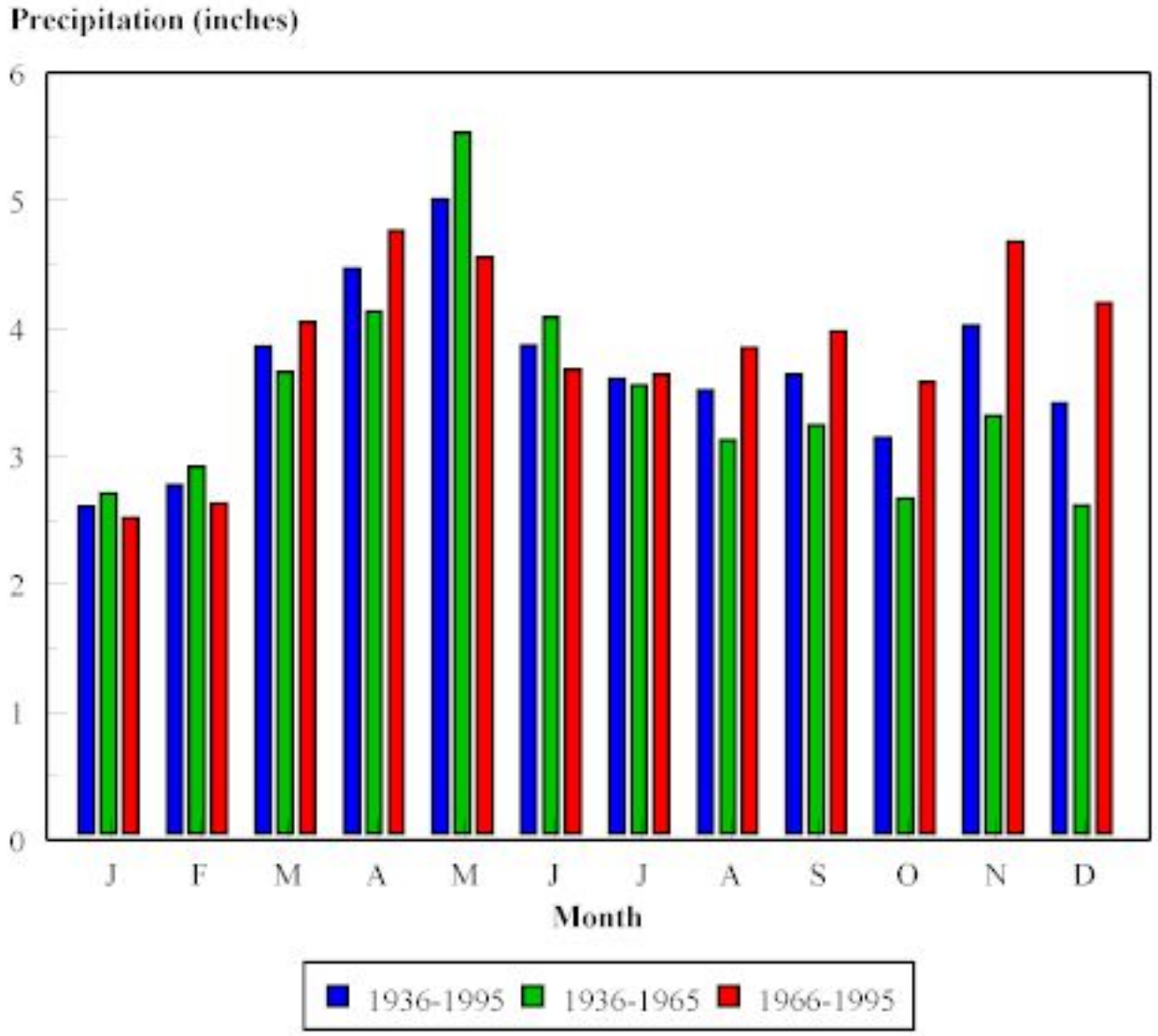


Figure Hy04. Change in daily mean discharge as well as precipitation by month between two time periods (1936-1965 and 1966-1995).

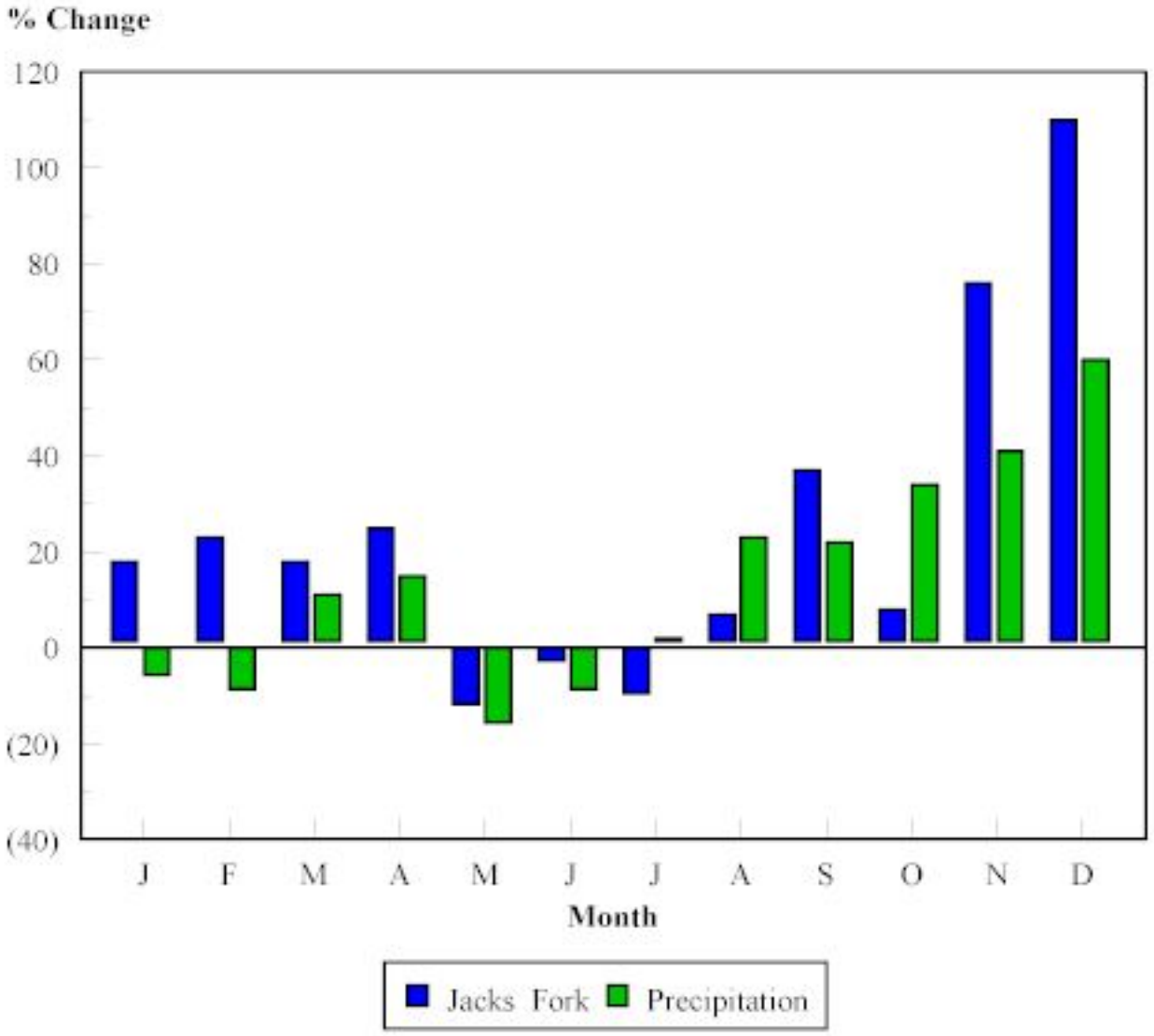


Figure Hy05. Daily mean discharge (dmd) by month at USGS Gage Station 07066000 (Jacks Fork River at Eminence, Missouri).

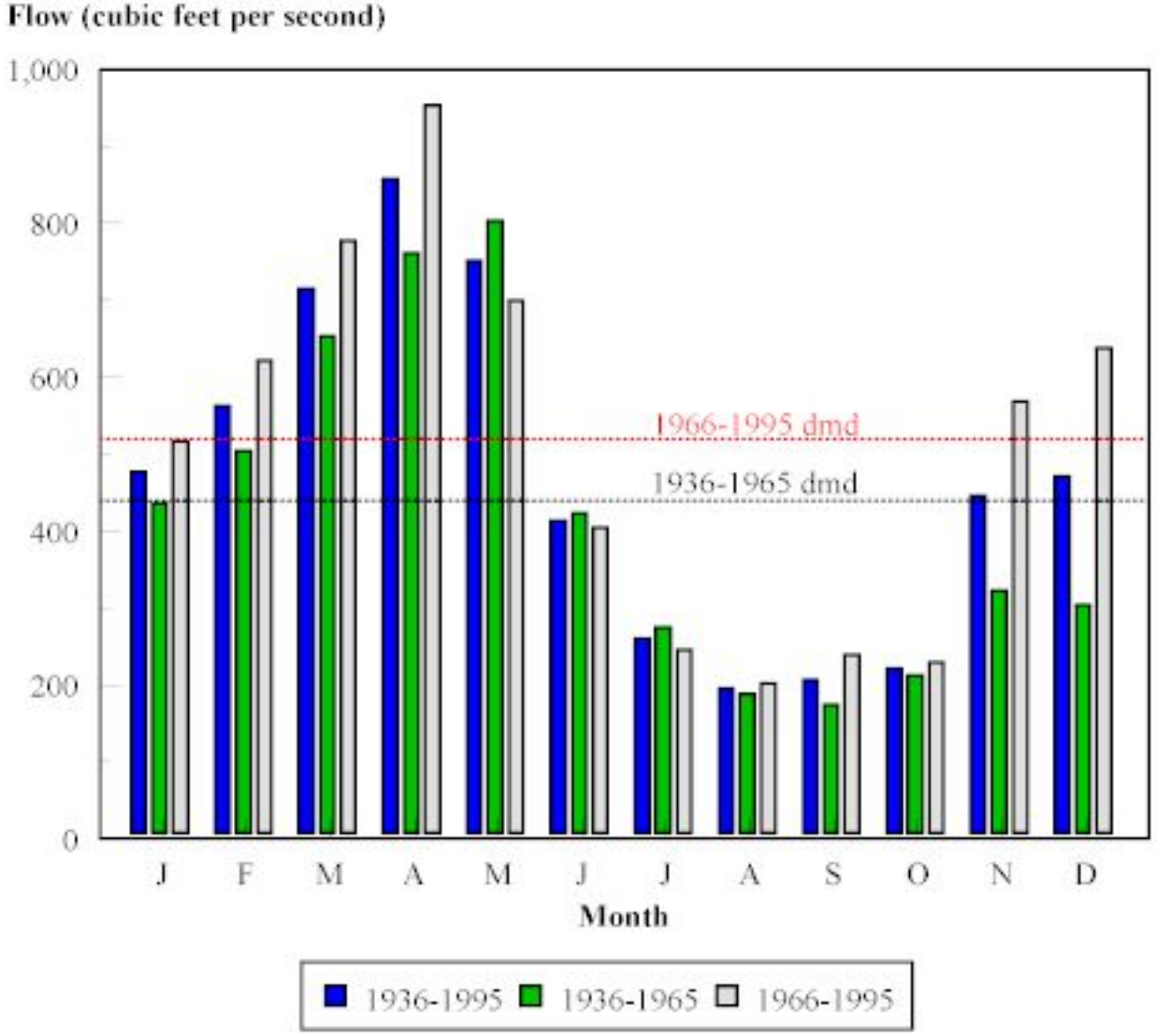


Figure Hy06. Flow duration changes between two time periods for Station 07066000 (Jacks Fork at Eminence) (USGS 2000c).

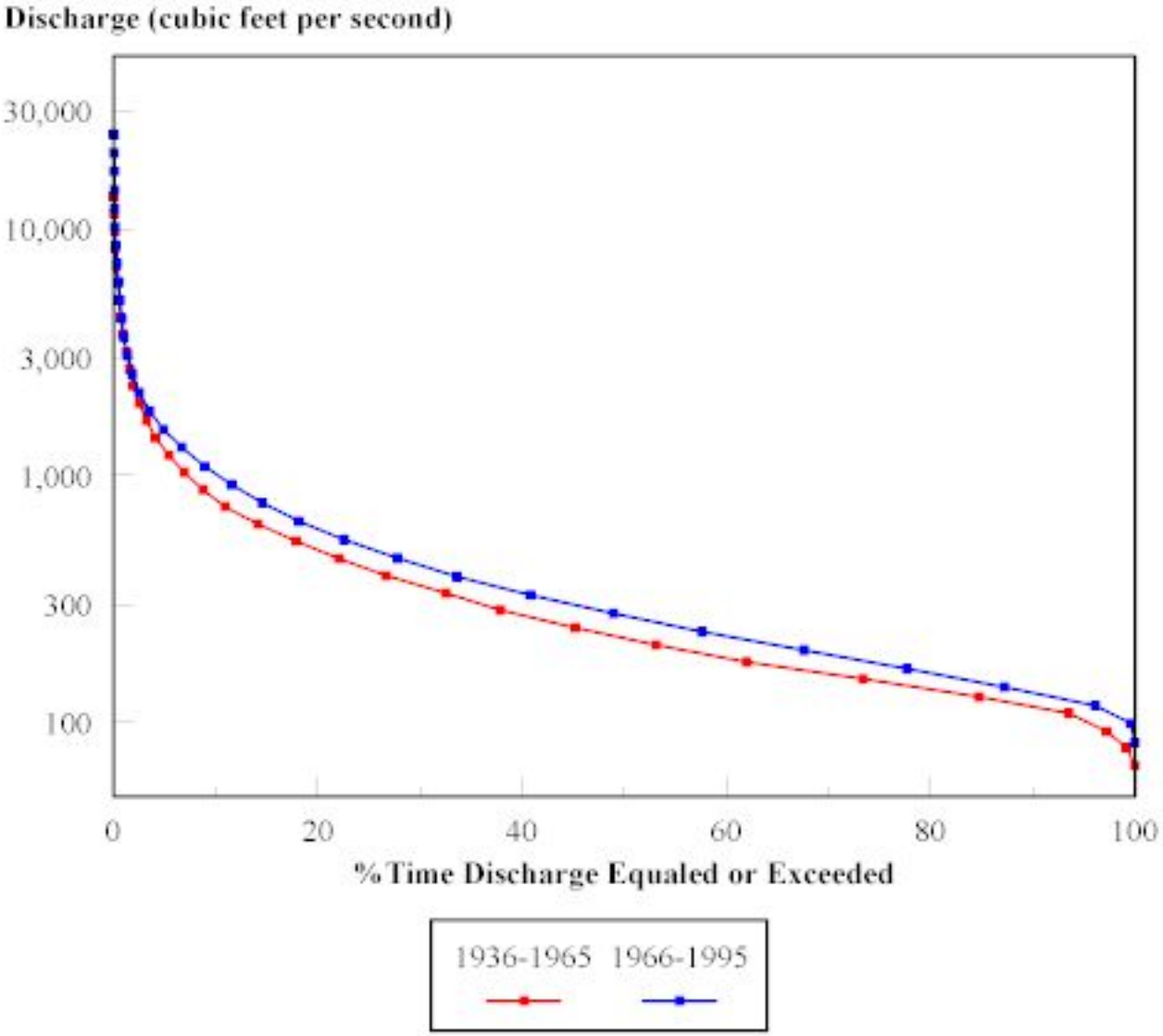


Table Hy01. United States Geological Survey surface discharge stations within the Jacks Fork Watershed (USGS 2000a).

Station #	Station Name	Drainage Area (mi^2)	Data Type	Period of Record
07066000	Jacks Fork at Eminence, MO	398	d,p	1921-Present (1999)
07065500	Alley Spring at Alley, MO	-	d	1928-1939 1965-1979
07065200	Jacks Fork near Mountain View	Not Available	s	2000-present
07065495	Jacks Fork at Alley Spring, MO	298	d,p	1993-Present (1999)

Record Type: d=daily discharge, **p**=peak flow, **s**=stage.

Table Hy02. Comparison of 10:90 ratios from the Jacks Fork and surrounding watersheds (Skelton 1976).

Station #	Name	Watershed	Drainage Area	10:90
07066000	Jacks Fork at Eminence	Jacks Fork	398	6.8
07057500	North Fork River near Tecumseh	North Fork	561	4.6
07058000	Bryant Creek near Tecumseh	North Fork	570	6.9
07066500	Current River near Eminence	Current	1,272	5.5
07067000	Current River at Van Buren	Current	1,667	5.0
07068000	Current River at Doniphan	Current	2,038	4.1
07070500	Eleven Point River near Thomasville	Eleven Point	361	22.9
07071500	Eleven Point River near Bardley	Eleven Point	793	5.4
06930000	Big Piney River near Big Piney	Big Piney	560	8.3

Table Hy03. Discharge statistics for United States Geological Survey Discharge Gage Stations within the Jacks Fork Watershed (USGS 1999a and USGS1999b).

Station	Avg. (cfs)	Instant Peak Flow (cfs)	Max (cfs)	Instant Low Flow (cfs)	Min (cfs)
07066000 (Jacks Fork at Eminence, MO)	466	48,500 11/15/1993	31,800 11/15/1993	64 8/28/1936	67 9/16/1956
07065500(Alley Spring at Alley, MO)	134	NA	1060 3/11/1935	NA	54 10/17/1934
07065495 (Jacks Fork at Alley Spring, MO)	308	48,700 11/14/1993	23,300 11/14/1993	52 9/11-15/1998	52 9/12/1993

Avg.=Average Daily Discharge

Max=Highest Daily Mean

Min=Lowest Daily Mean

Table Hy04. Magnitude of flood events (cubic feet per second) for selected recurrence intervals (years) at USGS Station 07066000 (Jacks Fork at Eminence) (Alexander and Wilson 1995).

Recurrence Interval (years)						
Site	**2**	**5**	**10**	**25**	**50**	**100**
Jacks Fork at Eminence	11,900*	24,200*	34,100*	48,200*	59,500*	71,500*

*cfs